STRUCTURE GEOTECHNICAL REPORT

Proposed SN 033-2013

Existing SN 033-0007

IL 14 over Tributary to LaKey Creek
FAP Route 855
Section 9B-1
Hamilton County

PTB 157 - Item 46
Contract No. 78343
Job No. D-99-004-13

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Date Revised: 7/02/2014

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Exhibits:
1) Location Map
2) Boring Locations
3) Subsurface Data Profile
4) Boring Logs
5) Slope Stability Output

Project Description and Proposed Structure Information

This project consists of replacing an existing single span bridge on closed abutments supported by spread footings carrying IL Rte. 14 at station 77+55.00 to accommodate proposed widening of the roadway, address deterioration of existing structure and satisfy hydraulic design requirements. The structure will carry one lane of traffic in each direction. The proposed structure is a 9'x7' triple barrel reinforced concrete box culvert, 45'-0" out-to-out headwalls measured along culvert centerline with 30 degrees left ahead skew. The proposed structure design will follow the LRFD Design Specifications. The proposed culvert opening has been increased to satisfy hydraulic design requirements. Complete removal of the existing structure will be required for construction. This work will need to be completed using stage construction.

The stage construction requires soil retention for excavation during removal of existing structure and construction of the proposed structure. The maximum fill height is approximately 2'-0" above the proposed culvert. The structure will have 11'-6" and 19'-6" long T-Type vertical cantilever wingwalls that will retain a 1:2 (V:H) embankment slope. The project site falls within Section 14 of Township 5 S and Range 6E of the 3rd Principal Meridian. A location map is presented in Exhibit 1.

Existing Information

The existing bridge is located at station 77+55.00. The existing structure was originally built in 1922 as S.B.I. Rte. 14, Section 9B, and was widened in 1952 as S.B.I. Route 14, Section 9BY. The structure consists of a single-span cast-in-place concrete slab on closed abutments supported by spread footings. Inside face to inside face of abutments is 28'-0". Superstructure width is 42'-4" out-to-out.

Site Investigation, Subsurface Exploration and Generalized Subsurface Conditions

The site is located in a rural area approximately 1.1 miles south east of McLeansboro, IL. The tributary flows from east to west. There are some trees along the tributary and flat fields to the east and west of the culvert. There are aerial electric lines on the north side of the structure, running parallel to the roadway.

The boring data was provided by IDOT District 9 personnel. Two borings drilled in October of 2013 are associated with the proposed culvert location. Boring 1-S was drilled at station 77+70 approximately 17 ft right of the centerline and was terminated at a depth of 18.5 ft below ground surface. Boring 2-S was drilled at station 77+39 approximately 16 ft left of the centerline and was terminated at a depth of 18.5 ft below ground surface. Both borings had rock cores taken from 18.5 ft to 33.5 ft depth. Boring locations relative to the culvert location are shown in Exhibit 2.

At each boring location, a standard penetration test (STP) was conducted every 2.5 ft according to AASHTO T 206 using a hollow stem auger drill. Borings 1-S and 2-S did not encounter ground water during or after drilling. Starting at ground surface the boring data depicts soft to medium brown silt loam to silty clay loam for approximately 7.5 ft with unconfined compressive strengths (Q_u values) of 0.4 to 0.9 tsf, SPT (N) values ranging from the weight of the hammer to 4 blows per foot, and moisture contents

ranging between 21% and 27%. Below the silty clay loam is approximately 5 ft of a medium to stiff brown and gray silty clay to silty clay loam with Q_u values of 0.7 to 1.5 tsf, SPT (N) values ranging from the weight of the hammer to 6 blows per foot, and moisture contents ranging between 21% and 24%. Below the silty clay to silty clay loam is approximately 5 ft of stiff to very stiff brown and gray clay with Q_u values of 1.7 to 2.3 tsf, SPT (N) ranging between 6 to 23 blows per foot, and moisture contents ranging between 19% and 24%. Borings encountered hard brown weathered clay shale and very dense brown sandstone before reaching the clay shale with sandstone rock layer. The rock was encountered at the depth of 18.5 ft at each boring location. Further description of the soil layers can be found in the boring logs attached in Exhibit 4 and Subsurface Data Profile in Exhibit 3.

Geotechnical Evaluations

Settlement: No significant changes in profile are proposed at the culvert location. The proposed culvert will replace the existing bridge. There will be increase in pressure between the existing abutments due to the weight of the culvert and new fill. The rock layer is located within 6 ft depth of culvert barrel. It is recommended the moist medium clay immediately below culvert barrel be removed down to the elevation of 402.1 and replaced with rockfill. Our preliminary calculations show there is no significant settlement in underlying stiff clay layers.

Slope Stability: Stability analyses were performed using a temporary excavation 1:1 slope model which rendered a factor of safety of 2.9. The resulting maximum excavation required for removal and replacement is 13 ft. No stability problems are expected.

Scour: The design scour elevations should correspond to the bottom of the toe wall elevation on upstream and downstream ends as shown in the table below. 10-year velocity thru the proposed culvert is 6.2 fps. Riprap should be provided at both ends for erosion protection. Estimated water surface elevation (EWSE) is 406.3.

Design Scour Elevation (ft.)	Upstream	Downstream
	400.45	400.20

Table 1

Mining Activity: A review of The Illinois State Geological Survey (ISGS) “Directory of Coal Mines in Illinois” for Hamilton County indicates that no mining activity has been present at the project location. The nearest underground coal mine is located 0.5 miles south of the culvert location.

Box Culvert Evaluations and Design Recommendations

Culvert Barrel. Based on hydraulic requirements and size limitations, a 3-sided structure is not a viable option.

Due to the District’s preference, potential complications during stage construction from the skew, high flow velocities and need for cast in place wingwalls the precast culvert option is not recommended.

With the large foundation area and proposed soil improvement at the culvert base, the bearing capacity at the base of the foundation was found to be more than adequate for resistance of estimated bearing pressures.

Wingwalls. There are several feasible options for selection of wingwalls. The wall type selection should be performed considering but not limited to soil conditions, length and economy.

Per IDOT Culvert Manual Figure 3.1.5-2, based on the 30° skew, 1:2 (V:H) slope behind the wingwall, and an estimated H_L of 10'-4", the wingwall length chart shows lengths of 11'-6" and 19'-6" with angles of 60° and 30° respectively.

The horizontal cantilever wingwalls are feasible at the northeast and southwest ends. Culvert Manual does not allow horizontal cantilever wingwalls with lengths exceeding 14 ft. Permanent sheet pile extensions are not recommended due to lack of embedment depth.

Vertical cantilever T-type walls are the most appropriate option at this location. The recommended active earth pressure as an equivalent fluid pressure on the cantilever wingwalls according to the proposed design is 45 pcf. Factored bearing resistance available is 3.2 ksf. A coefficient of friction for sliding of 0.5 is recommended.

Driven pile supported footings and driven soldier pile walls are not ideal options considering the shallow rock layer.

Gabion baskets appear to be feasible and can be constructed easily and quickly with traditional labor equipment. This wall can be labor intensive and expensive if a nearby stone source is not available. Factored bearing resistance available is 3.2 ksf. The recommended coefficient of friction for sliding of 0.5 and an active earth pressure as an equivalent fluid pressure is 45 pcf.

If during design phase it is determined that the vertical cantilever wingwalls are not an ideal option, horizontal cantilever wingwalls with extensions are feasible. Possible options for extensions are drilled soldier pile, gabion baskets and anchored permanent sheet pile walls.

A Geotechnical Design Memorandum will be required in the design phase if the drilled soldier pile or the permanent sheet pile option with anchorage system is chosen.

Construction Considerations

Cofferdams: In order to maintain a dry construction area, dewatering techniques may be necessary. However, based on an Estimated Water Surface Elevation (EWSE) of 406.3, a Type 1 cofferdam may be required if other methods cannot be utilized to keep the working area dry. Stream diversion could be utilized in order to facilitate construction of the box culvert.

Stage Construction: In order to maintain traffic flow, stage construction shall be utilized. To retain fill at the edge of slab during stage construction, it is recommended that temporary timber blocking be used to retain the Stage I fill. If this method is not

adequate, it may be necessary to provide a Temporary Geotextile Wall per IDOT Bridge Manual Fig. 3.13.2-1. Temporary sheet piles are not feasible for soil retention during stage construction according IDOT Bridge Manual Design Guide 3.13.1 (Temporary Sheet Piling Design) due to lack of embedment depth. It is recommended that a Temporary Soil Retention System be included in design plans.

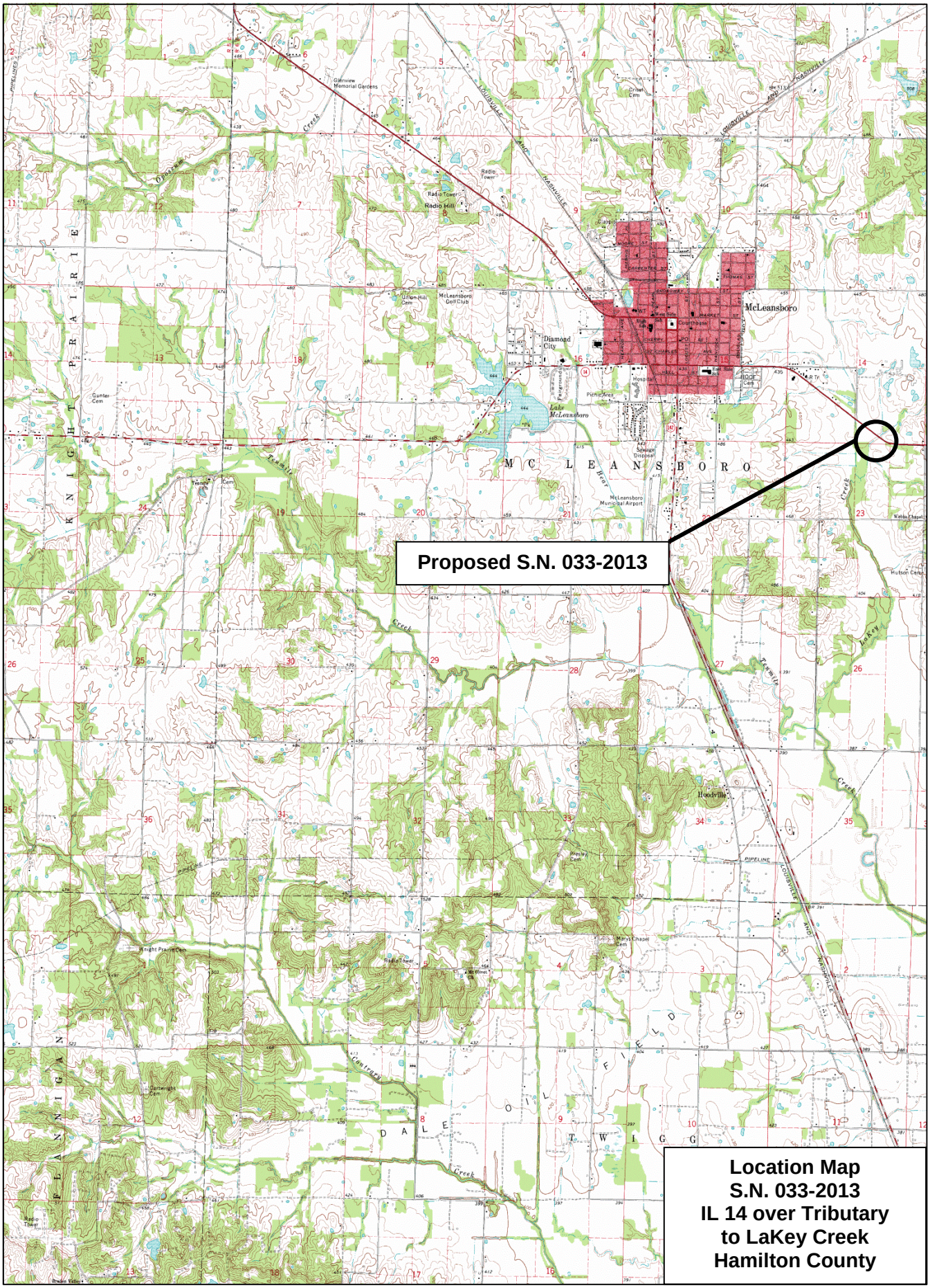
Excavation: A 1:1 temporary excavation slope for construction clearance has an adequate factor of safety. The factor of safety is limited to 1:1 slopes and any steeper slopes should not be used.

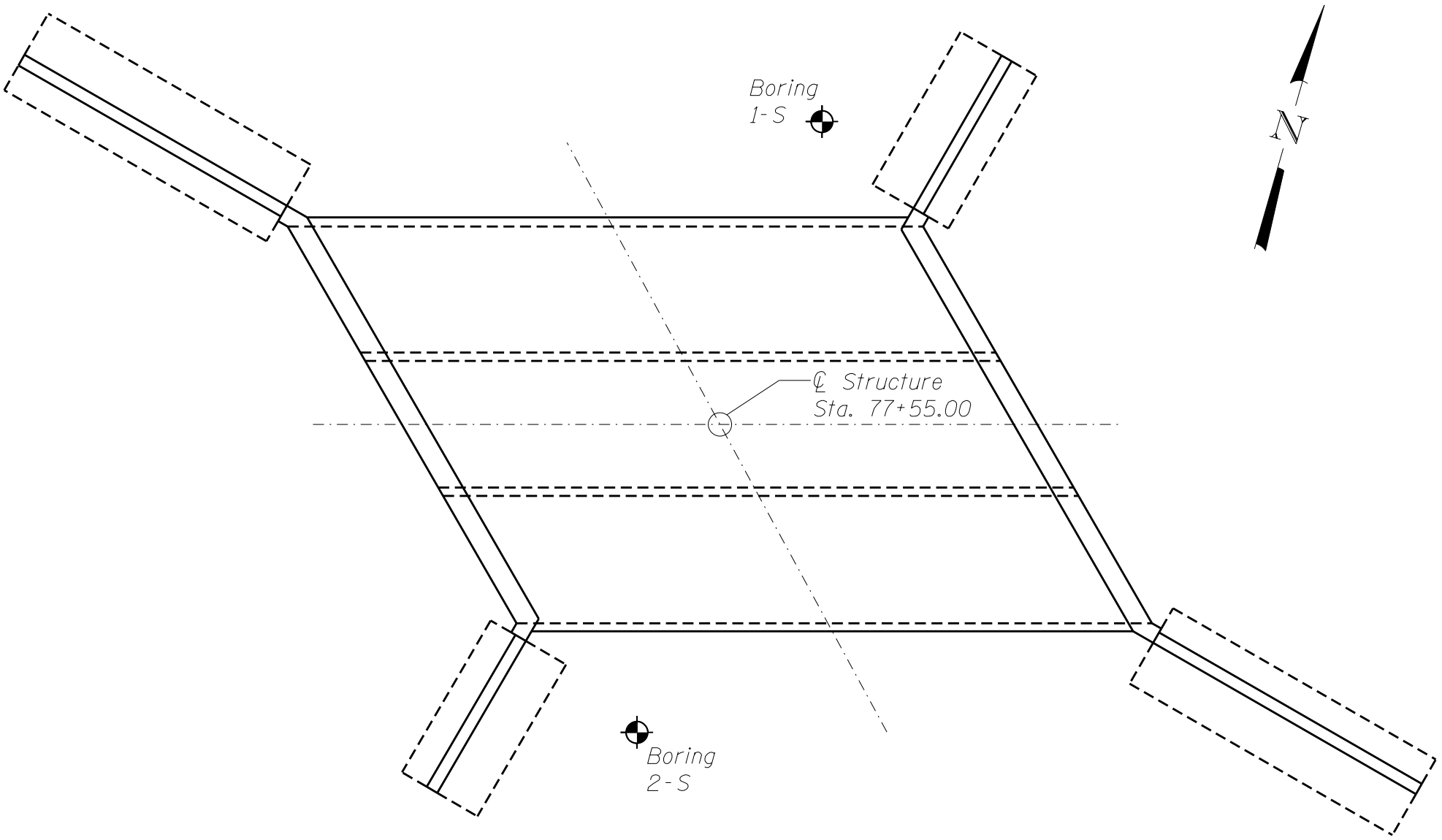
Backfill: Backfill on the sides of the culvert should be done within a 1:1 slope using Porous Granular Embankment. All other backfill may be composed of soil materials excavated from the project site placed and compacted according to the Standard Specifications.

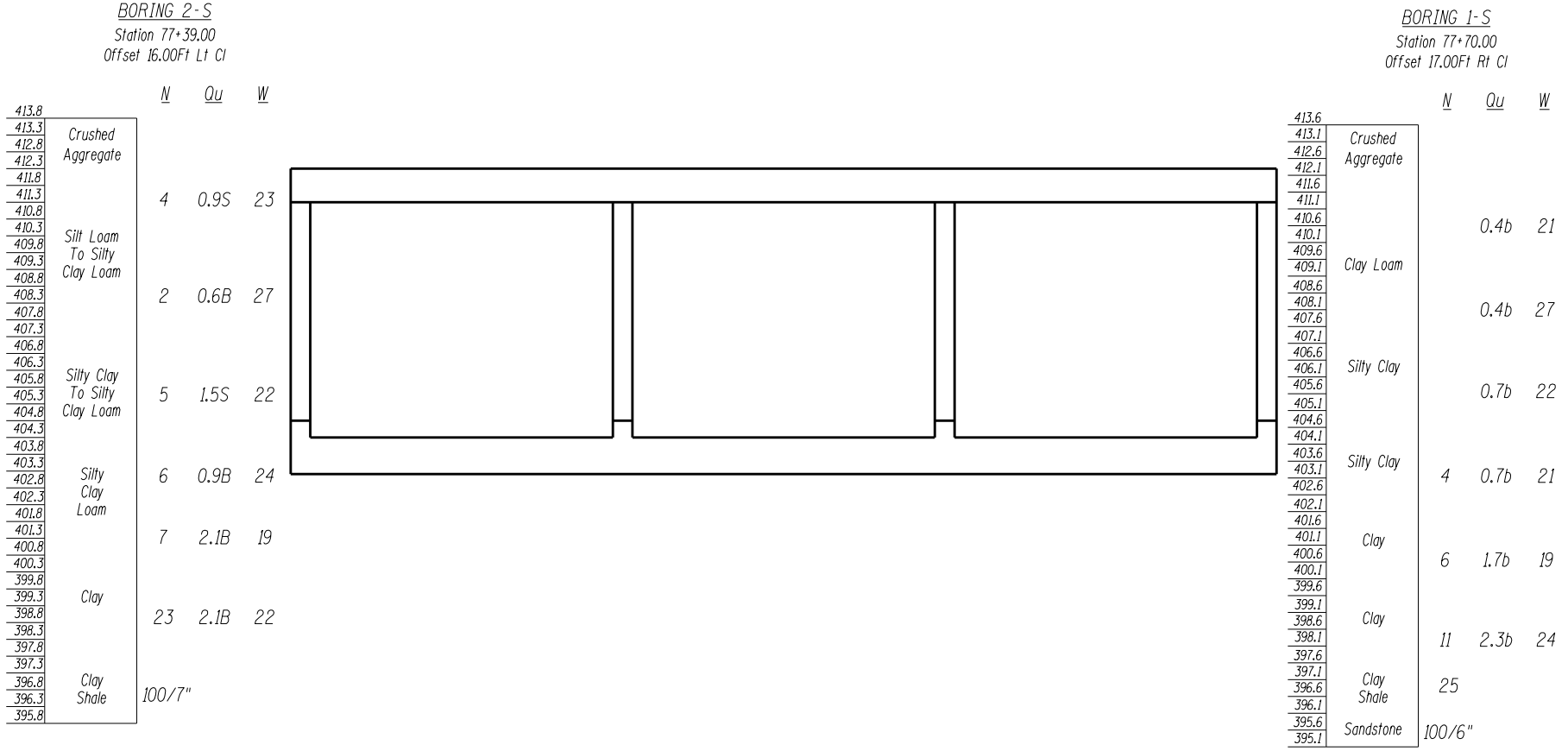
Ground Improvement: It is recommended the weaker top clay layer shall be excavated down to an elevation of 402.1 and replaced with rockfill. The pay limits shall extend 1 foot outside the limits of the barrel.

Limitations

The recommendations provided herein are for the exclusive use of IDOT and ESCA Consultants, Inc. They are specific only to the project described, and are based on subsurface information obtained at boring locations within the culvert area, our understanding of the project as described herein, and geotechnical engineering practice consistent with the standard of care. No other warranty is expressed or implied. Lin Engineering, Ltd. should be contacted if conditions encountered during construction are not consistent with those described.


Proposed S.N. 033-2013
McLeansboro
Hoodville
Diamond City
Lake McLeansboro
KNIGHT PRAIRIE
HANNING
OLIVE
TWIGG
DALE
Location Map
S.N. 033-2013
IL 14 over Tributary
to LaKey Creek
Hamilton County


Boring
1-S
℄ Structure
Sta. 77+55.00
N
Boring
2-S


BORING 2-S
Station 77+39.00
Offset 16.00Ft Lt Cl
N Qu W
413.8
413.3
412.8
412.3
411.8
411.3
410.8
410.3
409.8
409.3
408.8
408.3
407.8
407.3
406.8
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402.8
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401.8
401.3
400.8
400.3
399.8
399.3
398.8
398.3
397.8
397.3
396.8
396.3
395.8
Crushed Aggregate
Silt Loam To Silty Clay Loam
Silty Clay To Silty Clay Loam
Silty Clay Loam
Clay
Clay Shale
4 0.9S 23
2 0.6B 27
5 1.5S 22
6 0.9B 24
7 2.1B 19
23 2.1B 22
100/7"
BORING 1-S
Station 77+70.00
Offset 17.00Ft Rt Cl
N Qu W
413.6
413.1
412.6
412.1
411.6
411.1
410.6
410.1
409.6
409.1
408.6
408.1
407.6
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398.6
398.1
397.6
397.1
396.6
396.1
395.6
395.1
Crushed Aggregate
Clay Loam
Silty Clay
Silty Clay
Clay
Clay
Clay Shale
Sandstone
0.4b 21
0.4b 27
0.7b 22
4 0.7b 21
6 1.7b 19
11 2.3b 24
25
100/6"

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Dave Piche
From:	Keith Roberts	By: Rob Graeff
Subject:	*Boring Logs & Compressive Strength Results	
Date:	October 29, 2013	

FAP 855 (IL 14) over Stream
Structure 033-0007(E)
Hamilton County

Attached are copies of the boring logs and color photographs of rock cores obtained for use in the design of the referenced structure.

In addition, unconfined compressive strength tests were performed on suitable representative specimens to further define competent bedrock. These results are also attached.

Slope Stability
At the time of this report, a preliminary TSL is not available. Therefore, we are unable to provide any slope stability calculations for the proposed endslope configuration. This office should be contacted to complete the slope stability calculations when a proposed endslope configuration is determined.

Structure Geotechnical Report
Due to a current shortage of staffing, the District Nine Geotechnical Unit is unable to complete the required Structure Geotechnical Report. Any additional foundation recommendations should be evaluated by a competent consultant.

Attachments
RG:rg

cc: Soils File

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 1

FAP 855 (IL 14) Over Stream

Route: FAP 855 (IL 14) Structure Number: 033-0007 Date: 10/17/2013
Section 9, BY Bored By: R Moberly
County: Hamilton Location: 1.8 mi E IL 142 Checked By: R Graeff

Boring No 1-S
Station 77+70
Offset 17' Rt CL
Ground Surface 413.6 Ft

Surf Wat Elev: 405.3
Ground Water Elevation
when Drilling
At Completion
At: Hrs:

DEPTH	BLOW	Qu tsf	W%	DEPTH	BLOW	Qu tsf	W%
Crushed aggregate 412.6				100% Recovery; 70% RQD			
Soft, very moist, brown, Silty Clay Loam A-4	WH			Hard, dry, grey, Clay Shale and Sandstone			
	WH	0.4B	21	385.1			
	WH			Cored 28.5 to 33.5 feet			
5.0	WH			30.0			
	WH	0.4B	27	100% Recovery; 62% RQD			
	WH			Hard, dry, grey, Clay Shale and Sandstone			
406.6				380.1			
Medium, very moist, brown, Silty Clay A-6	WH						
	WH	0.7B	22				
	WH						
404.1							
Medium, very moist, grey mottled brown, Silty Clay A7-6 10.0	1				35.0		
	2	0.7B	21				
	2						
401.6				Bottom of hole = 33.5 feet			
Stiff, moist, brown mottled grey, Clay A7-6	1			No free water observed			
	3	1.7B	19				
	3			Elevation referenced to BM at SE corner; Elev.= 413.9 feet			
399.1							
Very stiff, moist, brown mottled 15.0	2			Borehole advanced with hollow	40.0		
grey, Clay A7-6	5	2.3B	24	stem auger (8" O.D, 3.25" I.D.)			
	6						
397.1				To convert "N" values to "N60"			
Hard, damp, brown, weathered Clay Shale 396.1	25			multiply by 1.25			
Very dense, dry, brown, Sandstone 395.1	100/6"						
Cored 18.5 to 23.5 feet							
20.0					45.0		
77% Recovery; 17% RQD							
Hard, dry, grey, Clay Shale with some Sandstone layers							
390.1							
Cored 23.5 to 28.5 feet							
25.0					50.0		

N-Std Pentr Test: 2" OD Sampler,140# Hammer, 30" Fall (Type Fail. B-Bulge S-Shear E-Estimated P-Penetrometer)

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 1

FAP 855 (IL 14) Over Stream
Route: FAP 855 (IL 14) Structure Number: 033-0007 Date: 10/21/2013
Section 9, BY Bored By: R Moberly
County: Hamilton Location: 1.8 mi E IL 142 Checked By: R Graeff

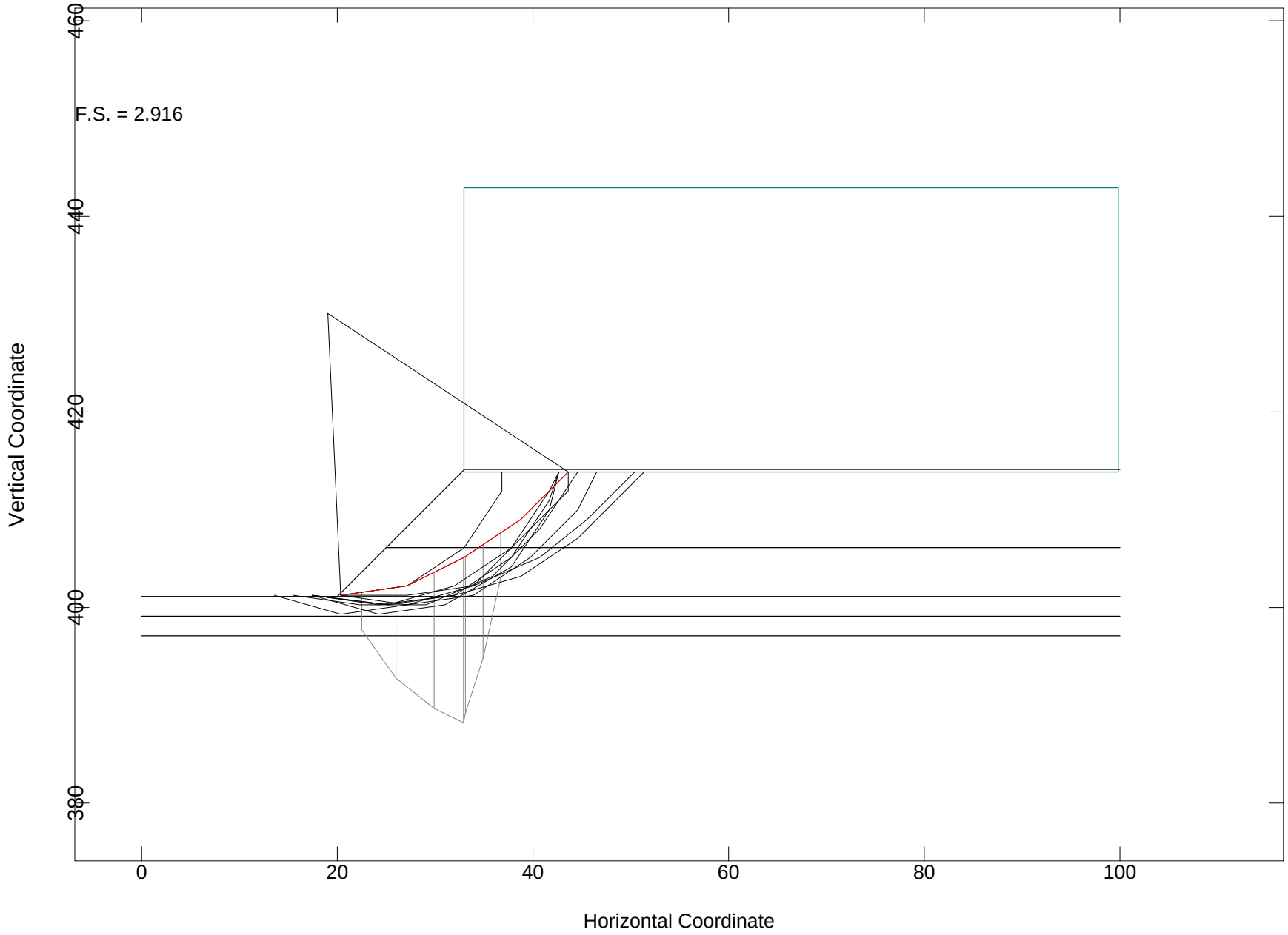
Boring No 2-S
Station 77+39
Offset 16' Lt CL
Ground Surface 413.8 Ft

Surf Wat Elev: 405.3
Ground Water Elevation
when Drilling
At Completion
At: Hrs:

DEPTH	BLOW	Qu tsf	W%	Notes
				Crushed aggregate
412.8				
				Medium, very moist, brown, Silt Loam to Silty Clay Loam A-4
	1			
	2	0.9S	23	
	2			
5.0	1			
	1	0.6B	27	
	1			
406.8				
	1			Stiff, moist, brown mottled grey, Silty Clay to silty Clay Loam A-6
	2	1.5S	22	
	3			
404.3				
10.0	1			Medium, very moist, brown mottled grey, Silty Clay Loam A-6
	3	0.9B	24	
	3			
401.8				
	1			Very stiff, moist, brown mottled grey, Clay A7-6
	3	2.1B	19	
	4			
15.0	2			
	13	2.1B	22	
	10			
397.3				
				Hard, dry, brown, Clay Shale
	100/7"			
395.3				
				Cored 18.5 to 23.5 feet
20.0				
				85% Recovery; 8% RQD
				Hard, dry, grey, Clay Shale with Sandstone layers
390.3				
				Cored 23.5 to 28.5 feet
25.0				

DEPTH	BLOW	Qu tsf	W%	Notes
				100% Recovery; 72% RQD
				Hard, dry, grey, Clay Shale
385.3				
				Cored 28.5 to 33.5 feet
30.0				
				95% Recovery; 32% RQD
				Hard, dry, grey, Clay Shale
380.3				
35.0				
				Bottom of hole = 33.5 feet
				No free water observed
				Elevation referenced to BM at SE corner; Elev.= 413.9 feet
				Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)
40.0				
				To convert "N" values to "N60" multiply by 1.25
45.0				
50.0				

N-Std Pentr Test: 2" OD Sampler,140# Hammer, 30" Fall (Type Fail. B-Bulge S-Shear E-Estimated P-Penetrometer)


F.S. = 2.916
Vertical Coordinate
460
440
420
400
380
0
20
40
60
80
100
Horizontal Coordinate